How the West Was One + Three x Four

Table of Contents

Introduction 1

Program Objectives 4

Program Description 5

- Overview 5
- How To Play 7
  - How To Make a Move 8
  - Order of Operations 9
  - Special Rules 10
  - Hints During the Game 10
- Playing West 12
  - The Computer's Best Move 16
  - The Computer As Opponent 17

Change Options 18

Notes from Field Tests 21

Overview of Classroom Lessons 22

- Classroom Lesson #1 24
  - Activity #1 - Transparency Masters 1A-1D 27
  - Activity #2 - Transparency Master 31
  - Activity #3 - Worksheet 32
  - Activity #3 - Answer Key 33
  - Activity #4 - Worksheet 34
  - Activity #4 - Answer Key 35
- Classroom Lesson #2 36
  - Activity #5 - Worksheet 38
  - Activity #5 - Answer Key 39
  - Activity #6 - Worksheet 40
  - Activity #6 - Answer Key 41
  - Activity #7 - Worksheet 42
  - Activity #7 - Answer Key 43
- Classroom Lesson #3 44
  - Activity #8 - Worksheet 46
  - Activity #8 - Answer Key 47
  - Activity #9 - Worksheet 48
  - Activity #9 - Answer Key 49
  - Activity #10 - Worksheet 50
  - Activity #10 - Answer Key 51
  - Activity #11 - Worksheet 52

Classroom Lesson #4 53
Activity #12 - Worksheet 56
Classroom Lesson #5 57
Activity #13 - Worksheet 59
Activity #13 - Answer Key 60
Activity #14 - Worksheet 61
Activity #14 - Answer Key 62
Activity #15 - Small Group Worksheet 63

At a Glance 64

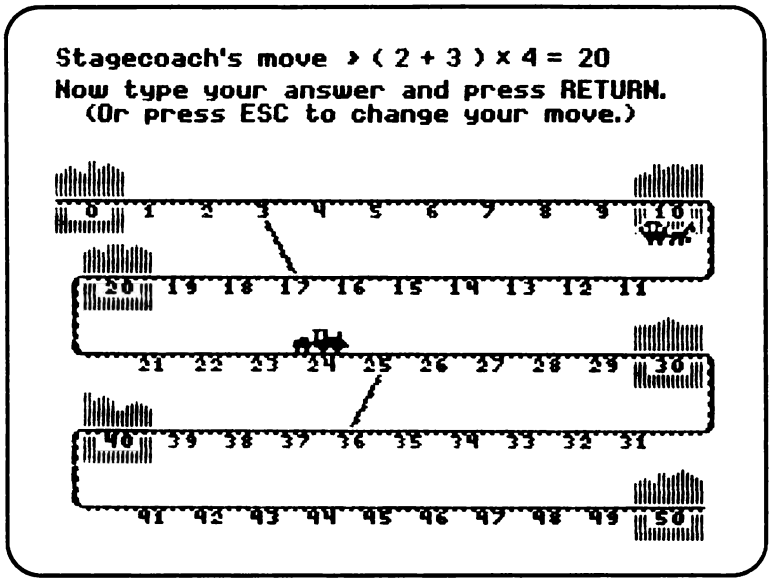
Working with the Apple 66
Working with the Apple II GS 67
Working with the IBM 68
Working with the Tandy 1000 69

"What Happens If...?" Sunburst Courseware and Warranty 70

HOW THE WEST WAS ONE + THREE x FOUR

Introduction

How the West Was One + Three x Four (**West** for short) is designed to provide a motivating game environment in which students can practice using arithmetic notation and expand their problem-solving strategies as they analyze a problem, consider alternatives, and select their best move.



A locomotive and stagecoach take turns moving along a number line trail in the Old West. Students move these vehicles by constructing arithmetic expressions, such as (2+3)x4=20, from three numbers randomly generated by spinners. On each turn, the players must determine which combination of the three numbers and the operations of addition, subtraction, multiplication, and division will produce the best move. Making the biggest number is not always the best move, since players can also bump their opponents, take shortcuts, and jump to the next town. The first one to land exactly in the last town is the winner and is welcomed with an animated banner. A summary of each student's performance is displayed and can be printed at the end of the game. Winners may choose to be included in the list of Top Ten Drivers.

Students are encouraged to "talk math"--to use mathematical terms in their conversations with friends--when they choose to play either competitively against each other or cooperatively against the computer. An individual student may also play against the computer. When playing against the computer, the level of play will be adjusted according to that of the student.

West is especially appropriate for students learning or reviewing the hierarchy of the order of operations and the significance of parentheses in an arithmetic expression. Special help is provided should a student think that 2+3x3 equals 15 instead of 11.

Hints help students improve their problem solving skills by suggesting game strategies and/or expressions that may not presently be in their repertoire of moves to consider. Students are challenged to compare their moves with what the computer considers the best. Advanced players will find opportunities to construct negative moves, such as 1x0-3=-3.

West combines arithmetic drill with problem solving. It addresses the strategies in the third level of the problem-solving matrix used by Sunburst. Although many strategies can be applied to **West**, it has been designed to place particular emphasis on three:

Selecting Appropriate Notation - Selecting symbols from mathematics that will represent ideas in a problem (+, -, x, ÷, <, >).

Identifying Multiple Solutions - Knowing that there may be 0, 1, or more solutions to a problem.

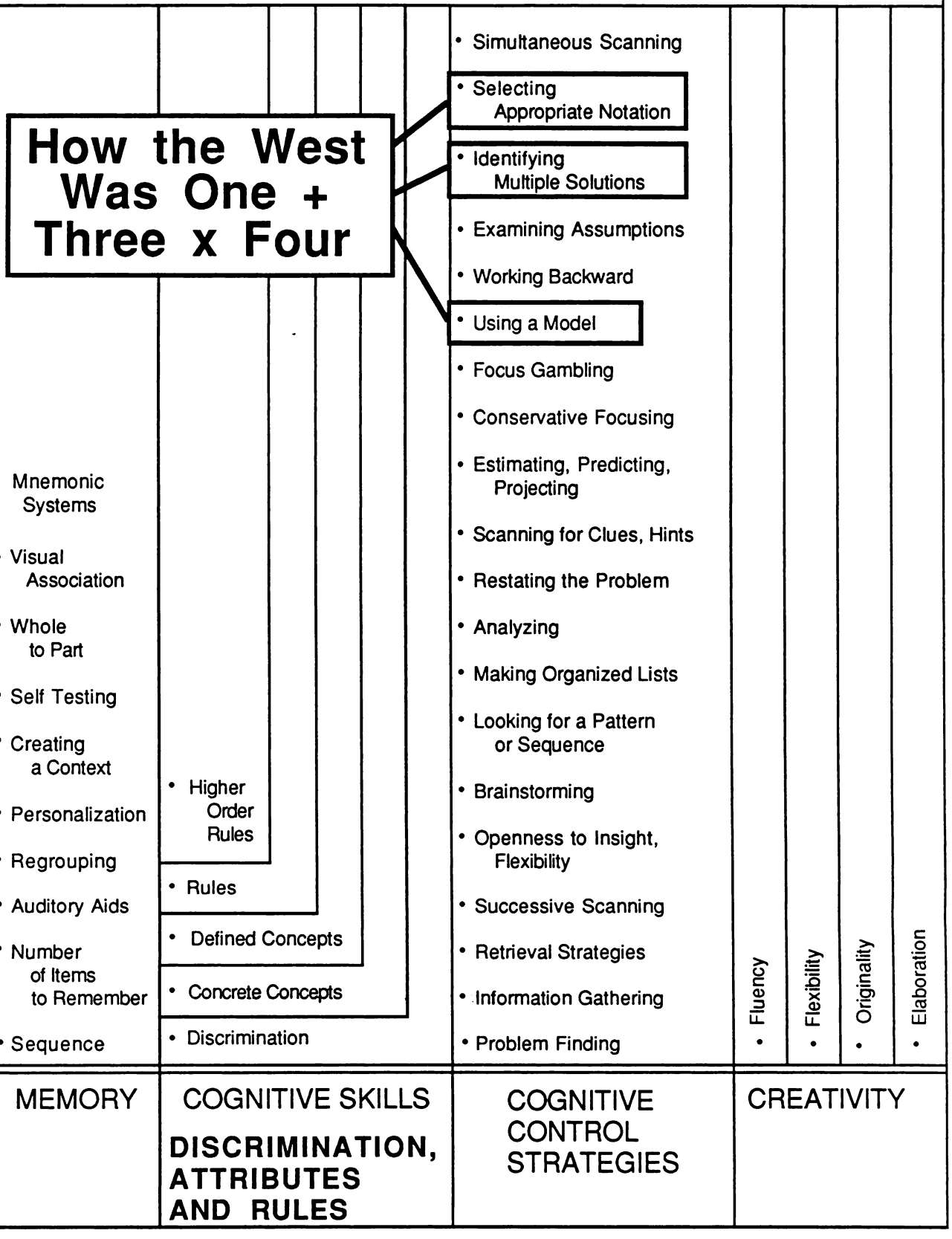
Using a Model - Constructing or examining an existing diagram, drawing, map, table, graph, roleplay, simple examples, similar problems, etc.

Students in problem-solving situations should be able to change variables, see how related conditions change, and determine how they want to proceed. **West** puts students into an environment which focuses on these types of activities. Students set up their own problem-solving strategies, then improve upon them as they play the game and receive feedback.

West has been described in several leading texts on computed-based instruction as a model for intrinsically motivating instructional games.

The program is designed for a 48K Apple II+, IIe, IIc, or IIGS with disk drive and a 256K IBM PC, IBM PS/2, or Tandy 1000.

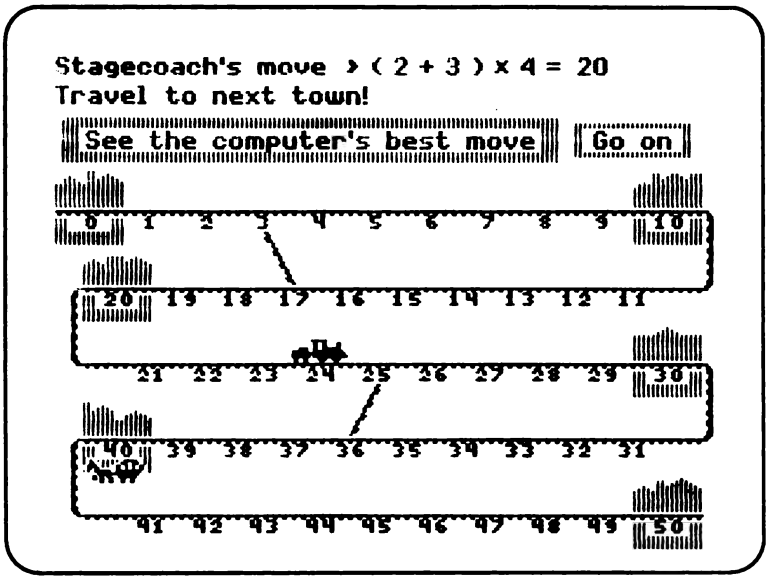
Problem Solving Skill Matrix



This matrix was developed under a Title IVC grant to Rochester, MN schools under the direction of Donna Stanger. The matrix is based on the works of Gagne, but also reflects Piaget, Guilford, Meeker, Bruner, Bloom and Torrance.

HOW THE WEST WAS ONE + THREE x FOUR

Program Objectives



Skills Needed: Addition, subtraction, multiplication, and division of whole numbers

Grade Level: 4th grade to adult

Reading Level: 3rd grade

Time Required: 15 to 20 minutes for Learn to play section
5 to 20 minutes per game

Objectives: To place students in situations where they analyze a problem, consider alternatives, and select their best move.

To increase computational skills using whole numbers.

To provide practice using arithmetic notation including parentheses to specify the order of arithmetic operations.

To provide situations that help students practice and appreciate the special properties of zero and one.

To encourage students to "talk math," using mathematical terms in discussing possible moves.

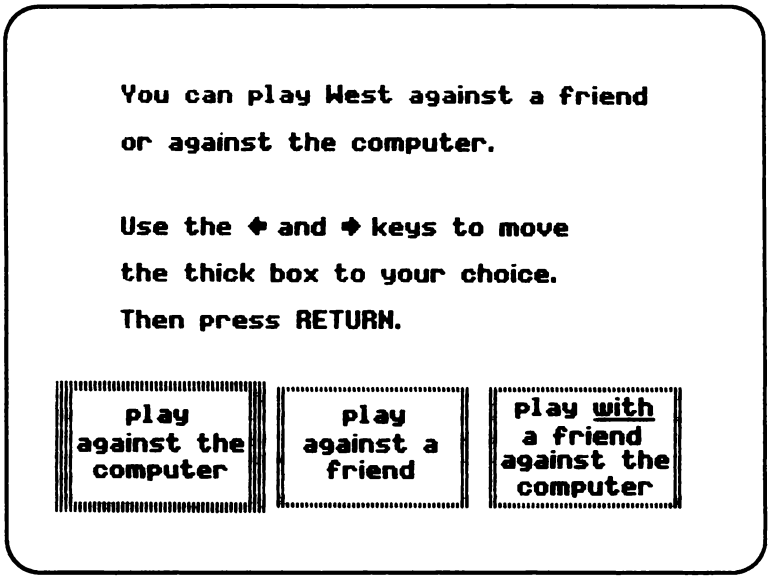
To provide an environment in which students, playing cooperatively or competitively, may learn from each other.

HOW THE WEST WAS ONE + THREE x FOUR

Program Description

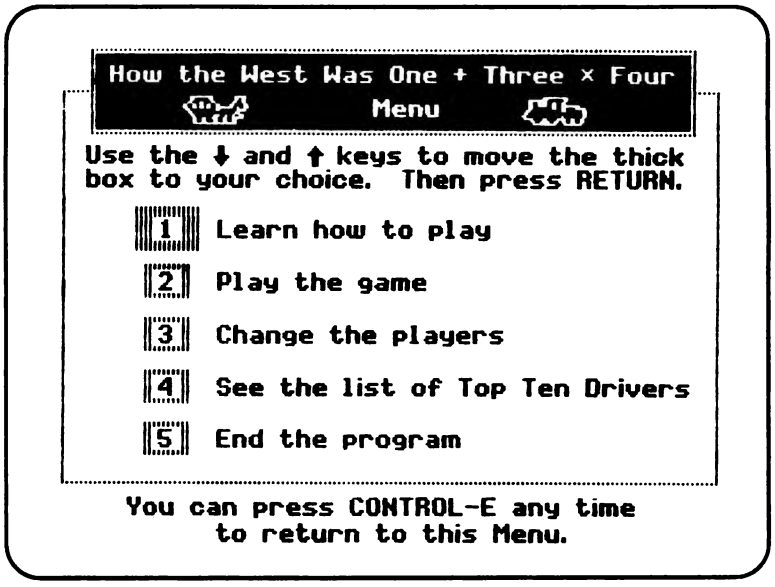
Overview

Players may play **West** (short for **How the West Was One + Three x Four**) in a competitive or a cooperative mode. Players first choose to play against each other or to play as a team or individually against the computer. When playing cooperatively, the opportunity to consider each other's suggested moves and to use mathematical terms in conversations is an important learning experience.


You can play West against a friend
or against the computer.
Use the ← and → keys to move
the thick box to your choice.
Then press RETURN.
play against the computer
play against a friend
play with a friend against the computer

Players are asked to type what they want to be called during the game. Those playing against the computer are asked to make up a name to call the computer. This may help players to differentiate between when the computer is the opponent and when the computer is operating the game. Whether playing against another student or the computer, one player becomes the engineer for the locomotive; the opponent is the driver for the stagecoach.

Players then see the main Menu for the game:


How the West Was One + Three × Four
Menu
Use the ↓ and ↑ keys to move the thick box to your choice. Then press RETURN.
1 Learn how to play
2 Play the game
3 Change the players
4 See the list of Top Ten Drivers
5 End the program
You can press CONTROL-E any time to return to this Menu.

To make a selection, players press the arrow keys to move the thick box to their choice and press RETURN. The ↑ and ↓ arrows can be used on an Apple IIe or IIc and the IBM PC, PS/2, or Tandy 1000. Players using an Apple II+ are directed to use the ← and → arrow keys. Selection can also be made by pressing a number key.

Players may go to any section. If they are not familiar with the game it is suggested that they choose **Learn how to play**.

Players familiar with the game select **Play the game** to go directly to the game setup.

Change the players enables players to change their names or their opponents'.

Players may choose **See the list of Top Ten Drivers** to see the ten most recent winners. The list will only include the names of students; even though the computer may win, that name is not saved on the list.

End the Program allows the players to leave the **West** and use another diskette or turn off the computer.

Holding down the Control (CTRL) key and pressing T will bring up the Change Options menu. This allows you to adapt the program to your students' particular situation. For example, you may turn off the printer option for players, remove the list of Top Ten Drivers, and change or delete names. See page 18 for details.

Please note: At any time during the program, players can exit a section and return to the Menu by holding the Control key and pressing the E key (CTRL-E).

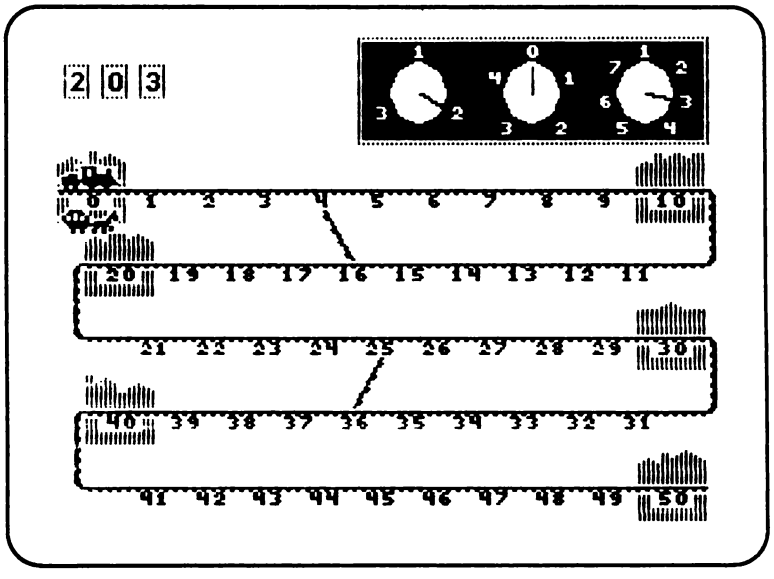
Also note: Players may press the ESC (ESCAPE) key to review or to return to the previous display. This option to go back is often listed on displays, especially those following a choice display. However, the ESC key option works everywhere in the program except (1) once the game has begun and (2) on a menu that lists a specific key for exiting.

HOW TO PLAY

First-time players are introduced to the game board; to the object, rules, and strategy of the game; and to the procedure for entering a move. Players are given a chance to practice making legal moves and are introduced to the two hints that are available during each game. Since good performance in **West** is dependent on knowing the order of the arithmetic operations, this mathematical convention is reviewed and practiced. (See Classroom Use: The Order of Operations, page 24, for a non-computer review.)

The **West** game board, shown below, consists of a trail (number line from 0 to 50) with a town at each multiple of 10, plus two shortcuts. The positions of the shortcuts differ for each game. The Locomotive and Stagecoach start at 0 and take turns moving along the trail; the first one to stop exactly at 50 is the winner.

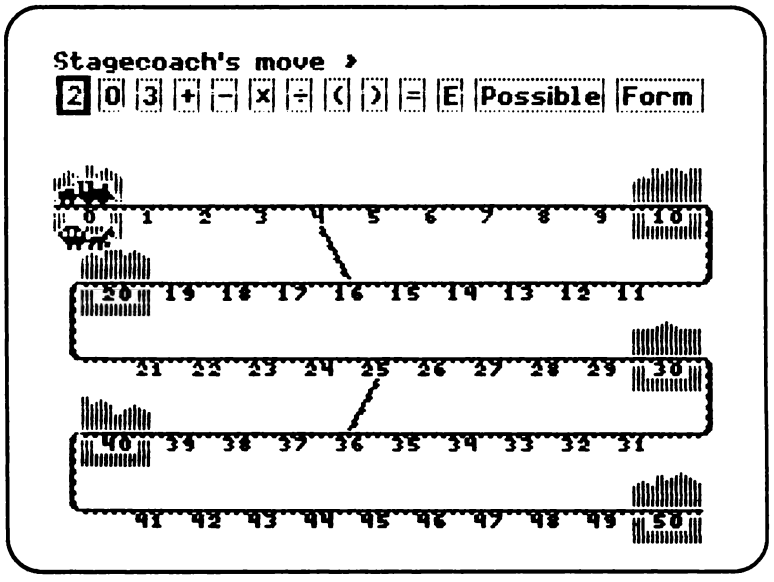
During a turn, each player receives three numbers from the spinners:



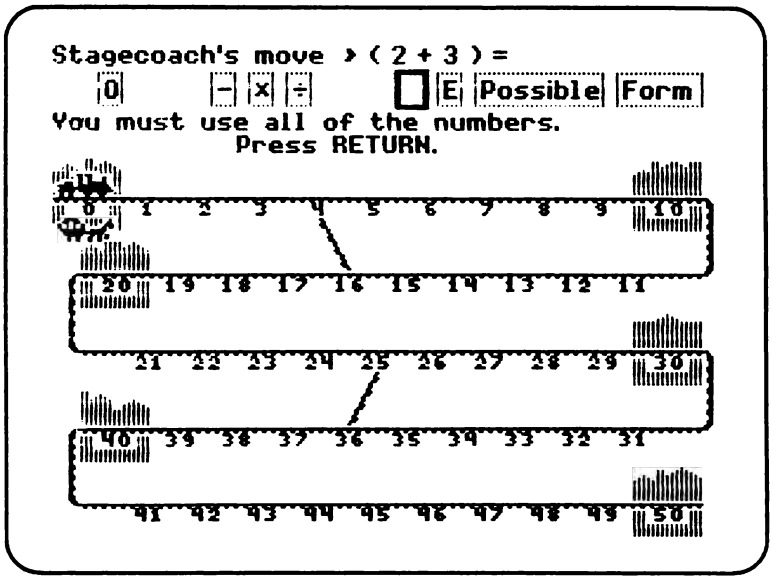
The players must combine these three numbers in an arithmetic expression (using the operations of addition, subtraction, multiplication, and division as well as parentheses), with two constraints:

- each number must be used once and only once
- do not use any operation or parentheses twice

For each turn, the three selected numbers plus the four operations and parentheses are placed in a row of option boxes.



How to Make a Move. Players construct their moves either by typing their expressions or by using the ← and → arrow keys to select a box. As a number or symbol is selected for the expression, its option box is removed from the row; this aids players in remembering the two constraints above. In addition, feedback is given any time players make an illegal selection, for example when the players indicate they are finished before using all three numbers.



Any error in mathematical syntax that players make while composing their moves is immediately pointed out. For example, players who type 2+1) receive the feedback

"You can't use) before you use (."

Similarly, a partial answer of 2++ results in

"You can't use that sign here."

After selecting or typing the equal sign, the players are required to type the answer; if correct, the players' piece moves that distance along the number line trail. If the answer is incorrect, the players are given the correct answer and do not move for that turn.

Note: The program accepts expressions that use implied multiplication, such as 4(2+3). The option box with the multiplication sign is erased when implied multiplication has been used.

Order of Operations. The order of arithmetic operations is reviewed in the Learn how to play section. It is referred to simply as "a rule in arithmetic that you need to know to play **West** well." Players are first asked to compute 2+2x3. For those who correctly answer 8, the order of operations convention is quickly summarized as follows:

To find the answer to a problem:
Do what is between the parentheses.
Do all x and ÷ next.
Do all + and - last.

Those who do not answer 2+2x3 correctly are led through the rule "Do all x and ÷ first; then do all + and -." Next, it is explained that "If you want to do + or - first, use (and);" the players then practice with the problem (2+2)x3.

A common error is to work a problem such as 2+1x4 from left to right and get 12. If players make this error during the game, the feedback provides a reminder of the need for parentheses around the addition, as in the example below:

> Sorry, the correct answer is 6, not 12.
> You needed to use (and) to get 12,
> like this: (2+1)x4=12.

The error is also mentioned in the players' summary at the end of the game and on the optional summary printout. The printout may be used to study from and seek the teacher's help if necessary.

When an expression involves only addition and subtraction, the operators are evaluated in left-to-right order, as in 6-3+2=5, not 1. Similarly, with multiplication and division, 6÷3x2=4, not 1.

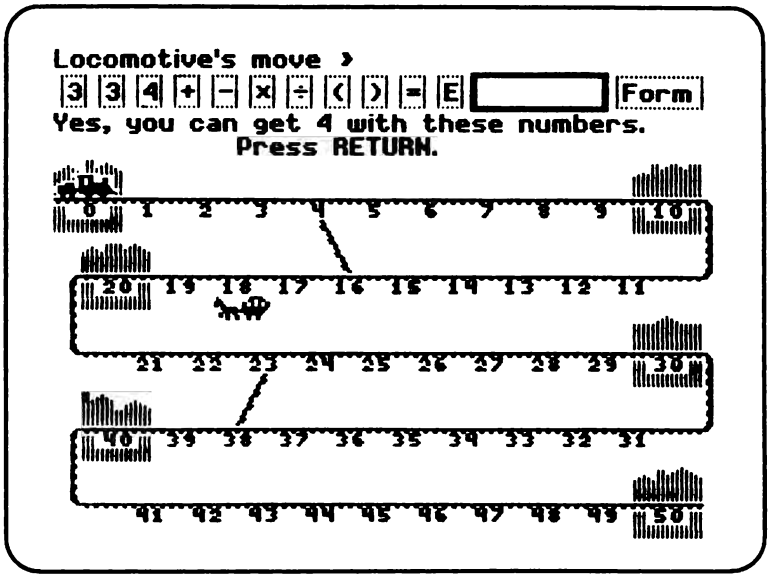
Special Rules. There are three Special Rules for **West** that serve to enrich the problem solving environment. The following rules are demonstrated for the players:

- If you land at the top of a shortcut, you slide down to the next line of track.
- If you land exactly where the other player is, you "bump" that player back two towns.
- If you land in a town, you automatically get moved ahead to the next town.

The numbers available from the spinners are small, so that special moves taking advantage of these rules are often better than the biggest move.

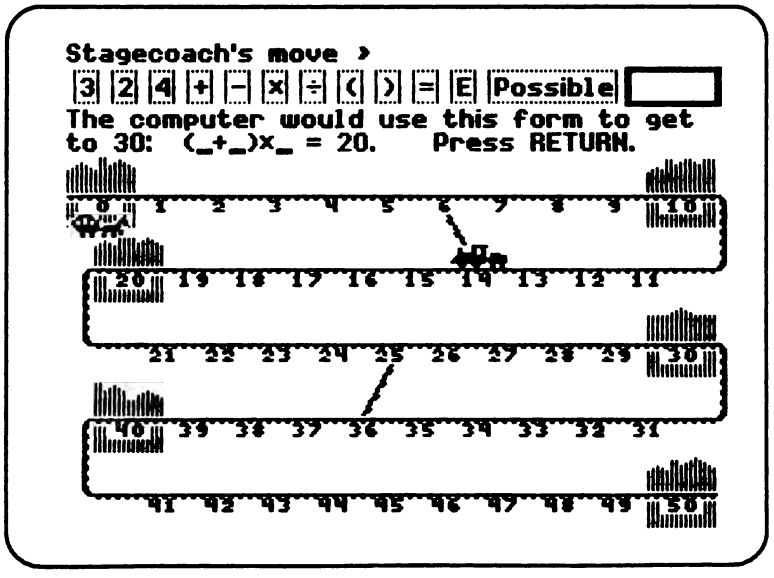
Hints During the Game. The game board provides two hints for each player during the game, one POSSIBLE hint and one FORM hint. The hints help players improve their problem-solving skills by suggesting game strategies and/or expressions that may not presently be in their repertoire of moves to consider.

When players choose the POSSIBLE box, they can ask the computer if it is possible to get a certain result using the three given numbers.



In the example above, the players are told whether a result of 4 is possible with the numbers 3,3, and 4, but are not told anything more. It is then up to the players to figure out what expression with these three numbers will produce the desired result of 4.

The FORM box provides a "stronger" form of help. When players choose this hint, the computer shows the form of the equation that it considers to be the best move with the given numbers. In the example below, the player is at 0 and has the numbers 3, 2, and 4 with which to work. Upon selecting the FORM hint, the player is shown (_+_)x_=20. It is then up to the player to try to determine which of the three numbers goes in each blank. In the example, the answer is (3+2)x4=20.

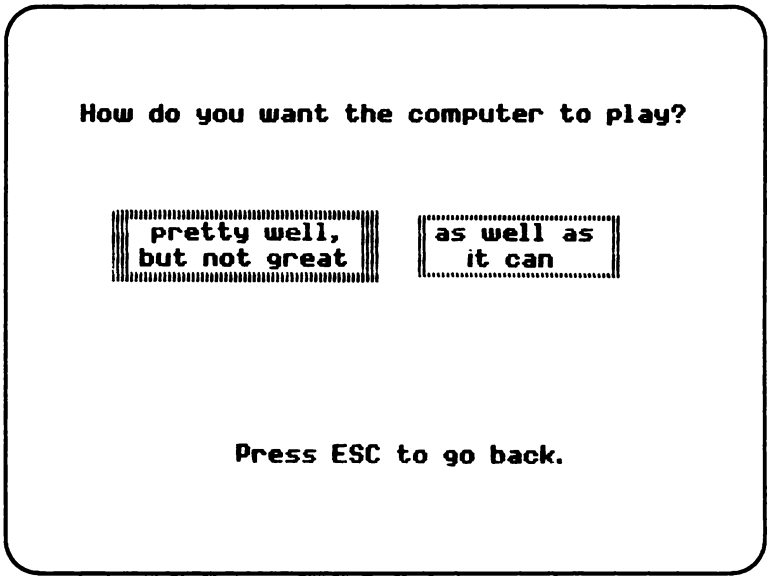


West's hints are covered as the last topic in the Learn to play section. Players then return to the main Menu, ready to begin play.

Playing West

When players select Play the Game on the main Menu, they are asked a few questions before starting the game.

Those playing against the computer are asked to select the level or quality of their opponent's play. A description of these two levels of play is provided in The Computer as Opponent (page 17).

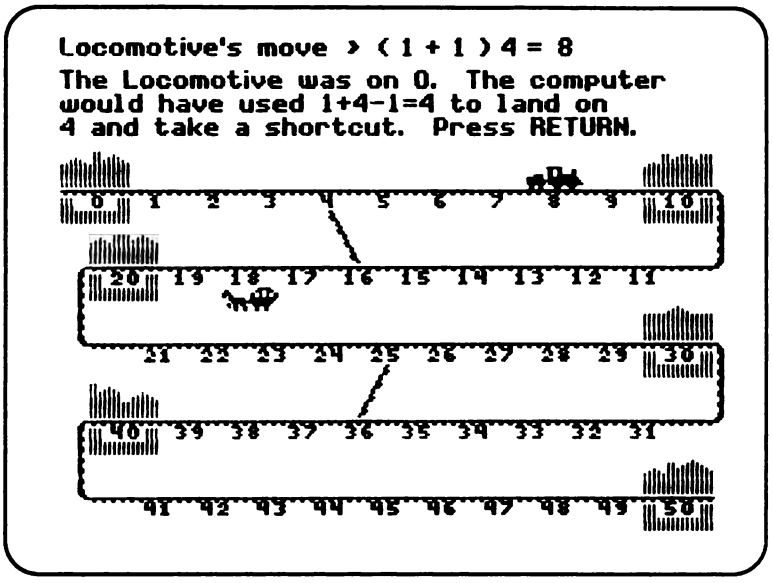


Players are also asked whether they would like to play with hints or without. Some competitive players enjoy challenging each other to a game that does not permit hints.

The computer randomly selects which player gets the first turn. Should the same players play a second game, the other player will go first.

Following each move, the players have the option to "See the computer's best move." This enables players to compare their moves with what is considered the best move.

Below is an example of a response that describes a move better than that made by the players.


Locomotive's move > (1 + 1) 4 = 8
The Locomotive was on 0. The computer would have used 1+4-1=4 to land on 4 and take a shortcut. Press RETURN.

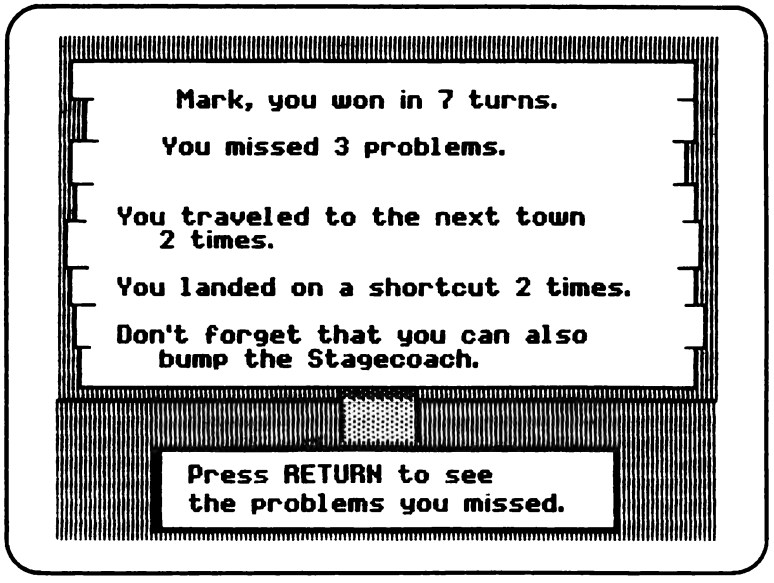
When the computer's "best move" matches that of the players, it responds, "The computer would have used the same move you did!"

The ESC key may be used to erase a move before it has been completed; however, a completed move can not be "undone" by pressing ESC. That is, players may not press ESC to go back to redo a move. ESC will back players out of the POSSIBLE hint option as long as they have not yet selected a result to check for.

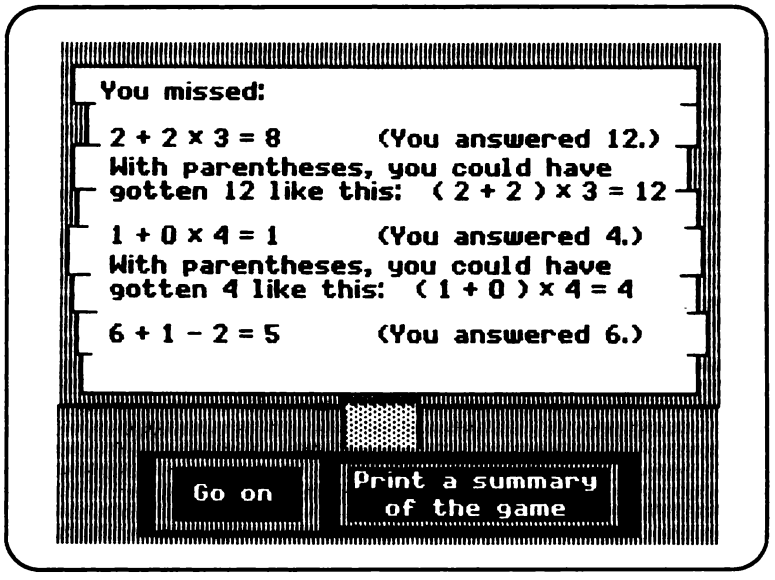
Players wishing to exit in the middle of the game may hold down the Control key and press the E key to return to the main Menu.

Players take turns making moves until one lands exactly on 50, the last town.
If players select a move that would go beyond 50, then they do not move on that turn. If the player who went first lands on 50, the other player gets one more move in order to try to tie. An animated banner flies to celebrate the winning or tying players.

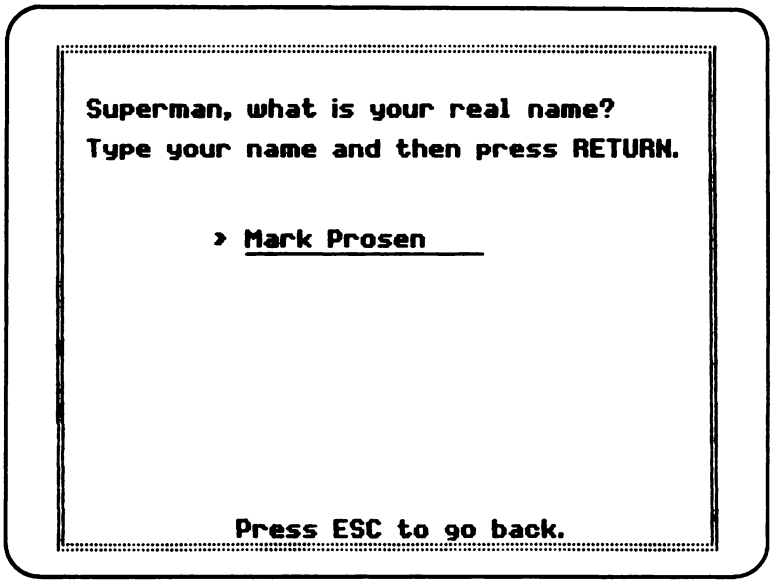
Following the game, players are shown a summary of their performance. Winners are told how many moves they made in order to win. Players are also told how many problems they missed and how many times they made use of each of the three Special Rules (taking short cuts, bumping back, and landing in a town).


Mark, you won in 7 turns.
You missed 3 problems.
You traveled to the next town 2 times.
You landed on a shortcut 2 times.
Don't forget that you can also bump the Stagecoach.
Press RETURN to see the problems you missed.

Any players who missed problems are shown a second display that lists each problem, along with the correct answer and the incorrect answer they made.

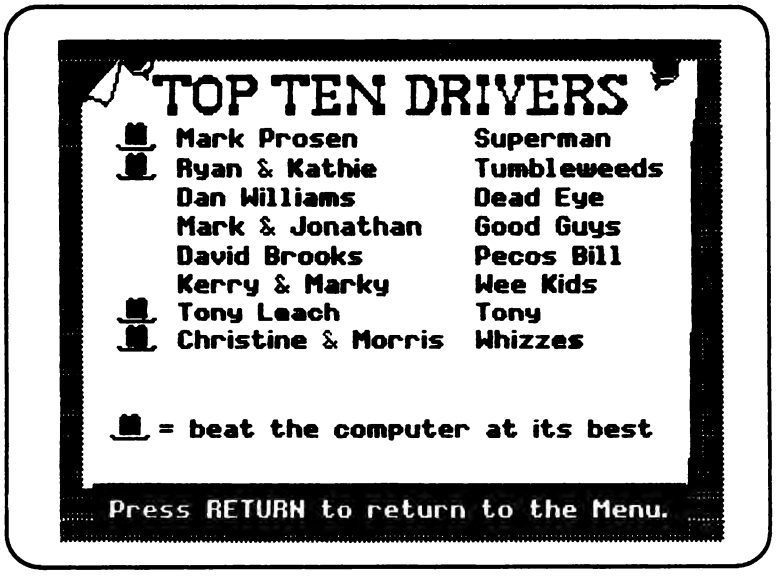

You missed:
2 + 2 x 3 = 8 (You answered 12.)
With parentheses, you could have gotten 12 like this: (2 + 2) x 3 = 12
1 + 0 x 4 = 1 (You answered 4.)
With parentheses, you could have gotten 4 like this: (1 + 0) x 4 = 4
6 + 1 - 2 = 5 (You answered 6.)
Go on
Print a summary of the game

If the printer option has been turned on for the program (See "Change Options" page 18), players may print a summary of the game. This gives both the player and the teacher a record of any computational problems the player might be having.



Winners may have their names placed at the top of the list of Top Ten Drivers.

They are asked to type their real names so that both their name for the game (nicknames) and their real names appear at the top of the list. (The Change Options menu enables teachers to change or delete any listing that they feel is not appropriate for others to see. They may also turn off the option to have a Top Ten list as part of the game.) A ten gallon hat identifies players whose opponent was the computer playing at its "best."


TOP TEN DRIVERS
Mark Prosen Superman
Ryan & Kathie Tumbleweeds
Dan Williams Dead Eye
Mark & Jonathan Good Guys
David Brooks Pecos Bill
Kerry & Marky Wee Kids
Tony Leach Tony
Christine & Morris Whizzes
= beat the computer at its best
Press RETURN to return to the Menu.

Following the game summaries and list of Top Ten Drivers, players return to the main Menu.

The Computer's Best Move. The complete list of equations needed to generate all unique moves using any three numbers from **West's** spinners is provided below. (Any equation that generates a move already covered by another equation is not included.)

"Simple" moves

a + b - c	(a + b) x c	a - (b + c)
(a - b) x c	a x b + c	a x b - c
a - b x c		

Moves involving division

(a + b) ÷ c	(a - b) ÷ c	a x b ÷ c
a - b ÷ c	a ÷ b + c	a ÷ b - c
a ÷ (b + c)	a ÷ (b - c)	

Moves involving negation

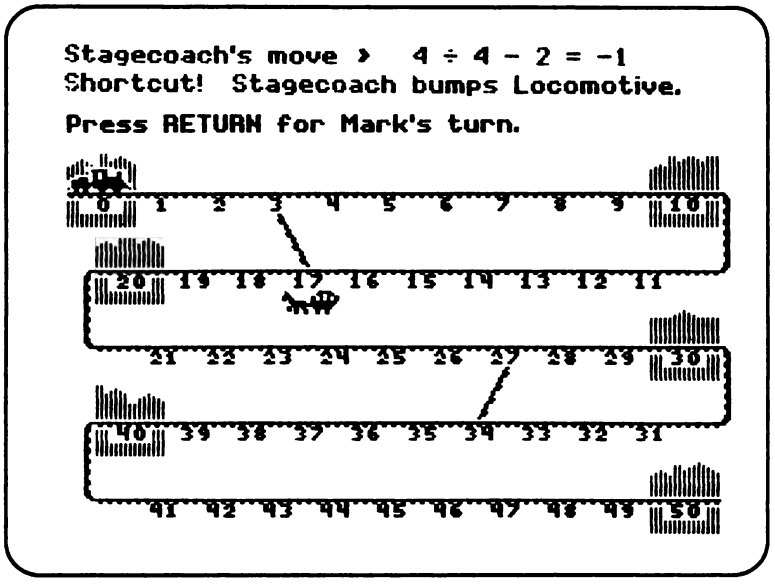
-(a + b) x c	-(a + b) ÷ c	-a x b ÷ c
-a ÷ (b + c)	-(a ÷ b + c)	

At the end of a turn, if the player requests to "See the computer's best move", the computer goes through the list above. The three given numbers for a, b, and c are substituted in every possible permutation; there are six in all:

a b c	b c a	c a b
a c b	b a c	c b a

The consequence of each equation is determined by taking into consideration the present locations of the stagecoach and locomotive, and the possibilities of bumping, shortcuts, and landing in a town. The computer determines where each player would be as a result of each possible move. If any move would win or tie the game, that one is used. Otherwise, the move that would result in the greatest distance ahead of the opponent (or the smallest distance behind a leading opponent) is used. This move is not necessarily the one that is the furthest along the number line trail; it may be a smaller move than results in bumping the opponent.

Occasionally when the three numbers are small, the best move may be one that has a negative answer. Players are often surprised when they first see a negative move by the computer.



Some players' strategies are more complex than the computer's "best move." Sophisticated players may choose a move that is actually better in terms of an overall strategy than the computer's "best move" for a particular board position. For instance, the computer program does not assess the playing ability of the opponent; the computer would always choose to land on 41 instead of 40, a safe town, while a very good player playing against a good opponent might choose 40 in order to be safe from a bump on the next turn.

The Computer as Opponent. When players choose to play against the computer, they select the level of the computer's play--either the computer playing:

1) pretty well, but not great or
2) as well as it can.

When the computer plays "as well as it can," it uses the same rules and strategy that it uses in determining the "best move," as described on page 16.

When the computer plays "pretty well," its objective is not to win, but to position its stagecoach not too far ahead or behind the players'. If the players are behind or just a little ahead, then the computer will usually make a rather small forward "simple" move that does not involve division or negative numbers. If the players have a fair lead, the computer will make a bigger "simple" move. If the players are at least 18 ahead, the computer will select the "best move" it can from the list of all possible moves--the same move it would use when playing at its best, even if it involves division or negative numbers.

HOW THE WEST WAS ONE + THREE x FOUR

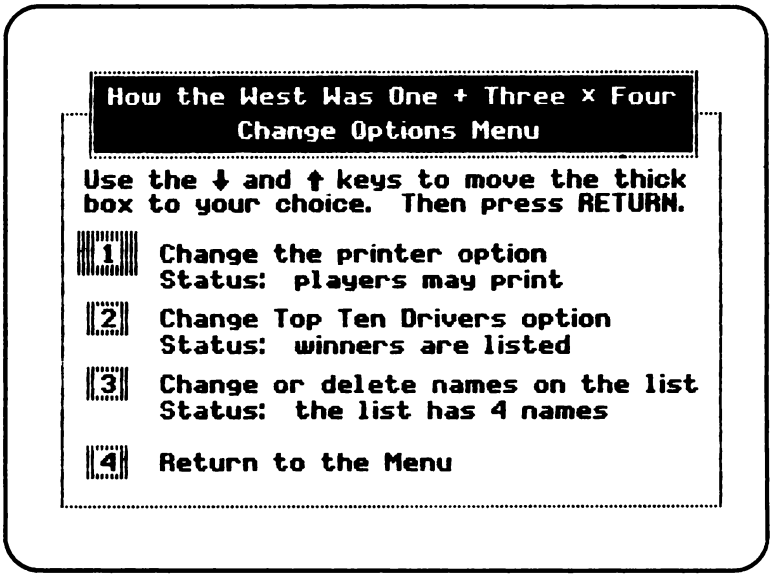
Change Options

The Change Options allow you to control certain elements of **West** in order to suit it to the situation in which your players play the game. You may

- turn on or off the printer option
- turn on or off the list of Top Ten Drivers
- change or delete names on the list of Top Ten Drivers

To access the Change Options Menu, hold down the Control (CTRL) key and press T on the main Menu.

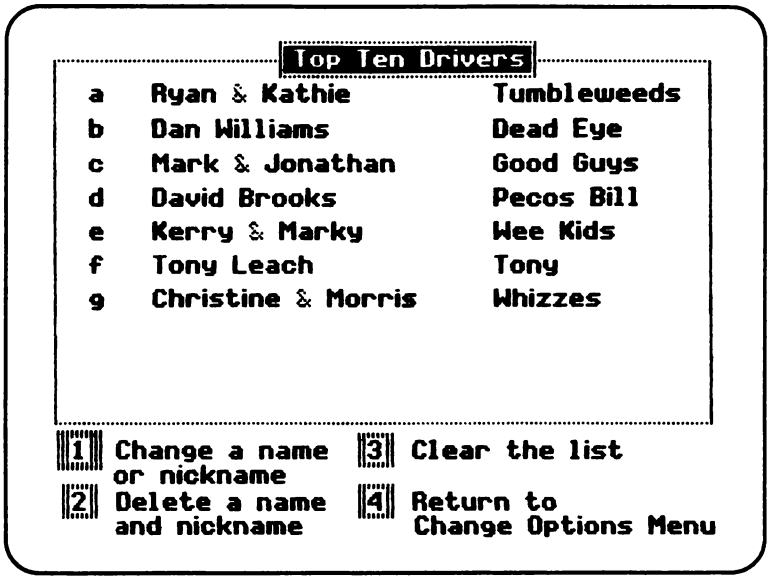
The Change Options Menu provides four options:


How the West Was One + Three x Four
Change Options Menu
Use the ↓ and ↑ keys to move the thick box to your choice. Then press RETURN.
1 Change the printer option
Status: players may print
2 Change Top Ten Drivers option
Status: winners are listed
3 Change or delete names on the list
Status: the list has 4 names
4 Return to the Menu

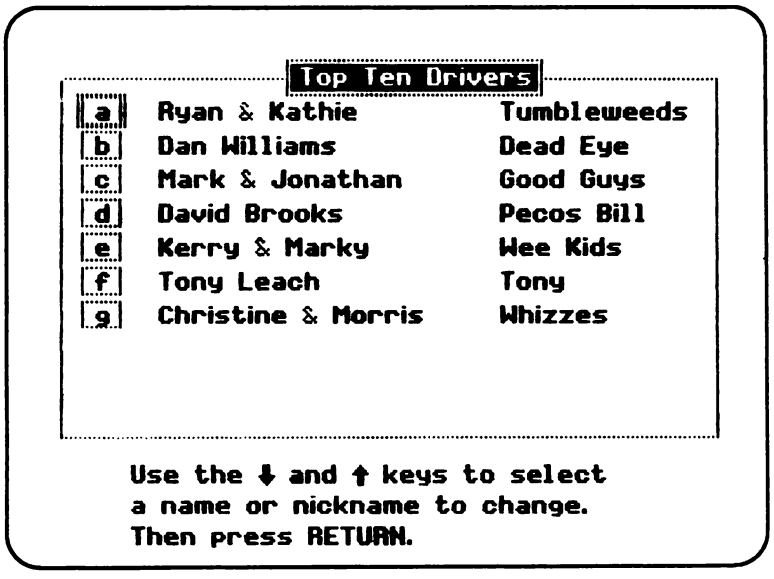
1. To turn off/on the printer option for players, select the first choice. If the printer option is off, players will not be given the option at the end of the game to print a summary of their game. This option should only be turned on if the players play at a computer that has a printer attached.

2. To turn off/on the list of Top Ten Drivers, select the second choice on the Change Options Menu. When this option is off, players who win the game are not given the option to have their names added to the list. Also, there is no option to "See the list of Top Ten Drivers" from the game's menu.

3. To change or delete one or more names on the list of Top Ten Drivers, select the third choice on the Change Options Menu . You will be shown the current list of Top Ten Drivers and four options as follows:


Top Ten Drivers
a Ryan & Kathie Tumbleweeds
b Dan Williams Dead Eye
c Mark & Jonathan Good Guys
d David Brooks Pecos Bill
e Kerry & Marky Wee Kids
f Tony Leach Tony
g Christine & Morris Whizzes
1 Change a name or nickname
2 Delete a name and nickname
3 Clear the list
4 Return to Change Options Menu

Change a name or nickname allows you to change a student's name (left column) or nickname (right column). Use the arrow keys or type a letter to select a name or nickname to change; then press RETURN.


Top Ten Drivers
a Ryan & Kathie Tumbleweeds
b Dan Williams Dead Eye
c Mark & Jonathan Good Guys
d David Brooks Pecos Bill
e Kerry & Marky Wee Kids
f Tony Leach Tony
g Christine & Morris Whizzes
Use the ↓ and ↑ keys to select a name or nickname to change. Then press RETURN.

To change the name, type the new name at the prompt and press RETURN. If the name is correct as shown, press RETURN to proceed to the "new nickname" option.

To change the nickname, type the new nickname at the prompt and press RETURN. If the nickname is correct as displayed, press RETURN to leave it as is and proceed.

Delete a name and nickname allows you to delete a student's name and nickname from the list. The deletion is made if you answer "yes" to the question "Are you sure?"

Clear the list enables you to clear all the names from the list at once. The deletion is made if you answer "Yes" to the question, "Do you really want to delete the entire list?"

Return to Change Options Menu brings you back to the Menu so you can change another option or return to the main Menu.

4. To return to the Menu when you have finished using the Change Options, select the last choice on the Change Options Menu and press RETURN. This will save the options as selected and return you to the main Menu.

How The West Was One + Three x Four

DESCRIPTION

How the West Was One + Three x Four is a math strategy game in which students construct arithmetic expressions in an old west environment. The result of the arithmetic expression advances a locomotive or stagecoach along a number trail. Students construct their arithmetic expressions using +, -, x, /, and parentheses along with three random numbers generated by the program on three visual spinners.

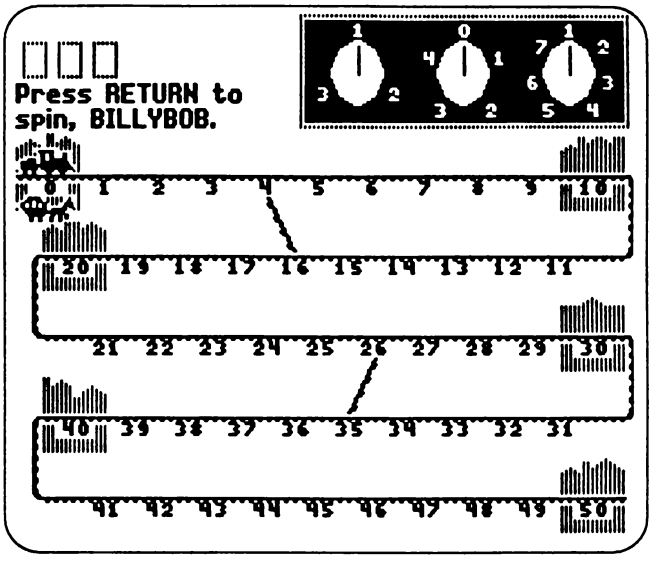
Along the trail there are five imaginary towns. The student who lands on the last town first wins. There are shortcuts along the trails and students can bump their opponent by landing exactly on top of their opponent. They can also advance ahead of the opponent by creating larger answers with their math expressions. The major sections of the program are:

Learn How to Play - Players are introduced to the program through an interactive tutorial.

Play the Game - Players go directly to the game setup. They elect to play against another player or the computer.

Change Players - Enables players to change the names of the players.

List of Top Ten Drivers - Includes a list of the ten most recent student winners.



GETTING STARTED

Introduce the gameboard (picture shown at top right) to the class. Explain that three random numbers are generated by the three spinners on the board.

Ask two students to create expressions using the three random numbers and then have them figure out their answers. Move the locomotive on the board according to the first student's answer and the stagecoach for the second. If they land on a shortcut follow the shortcut down. If one of them lands on top of the other, move the other player back two towns.

Tell students they will now play the same game on the computer.

AT THE COMPUTER

Step 1: Start by selecting Learn How to Play from the main menu and going through it with groups.

Step 2: Allow students to practice at this level before moving on to Play the Game.

Step 3: Suggest that pairs of students play cooperatively against the computer before competing against each other.

SUGGESTED EVALUATION

Ask students the following questions:

- What is the goal in this particular situation?
- What is the best strategy to use?
- Is there another way to achieve the goal?

SPECIAL KEYS

- CTRL-E exits program at any time
- CTRL-T accesses Teacher Change Options